# ANATOMICAL SOCIETY OF GREAT BRITAIN AND IRELAND

# PROCEEDINGS

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NOVEMBER 1903

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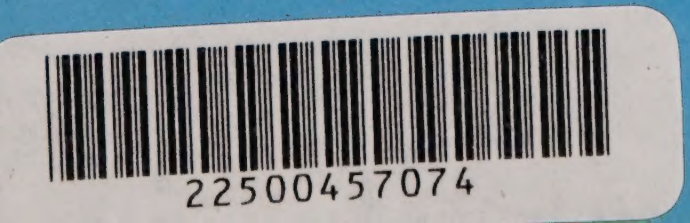

PROCEEDINGS OF THE

# ANATOMICAL SOCIETY OF GREAT BRITAIN AND IRELAND.

## NOVEMBER 1903.

A MEETING of the Anatomical Society of Great Britain and Ireland was held in the Library of the Medical School, St Mary's Hospital, London, W., on Monday, November 23rd, at 4 p.m. Mr C. B. Lockwood (the President) was in the chair, and eighteen members and four visitors were present.

The minutes of the last meeting were read and confirmed.

The following gentlemen were elected as the Officers and the Council of the Society for the ensuing year:—*President*—J. Symington, M.D., F.R.S. *Vice-Presidents*—Arthur Thomson, M.B.; A. M. Paterson, M.D.; J. Yule Mackay, M.D. *Treasurer*—F. G. Parsons. *Secretaries*—Peter Thompson, M.D. (England); R. J. A. Berry, M.D., F.R.S.E. (Scotland); R. A. Stoney, M.B. (Ireland). *Council*—C. Addison, M.D.; A. Birmingham, M.D.; T. H. Bryce, M.D.; D. J. Cunningham, M.D., F.R.S.; A. F. Dixon, M.B.; E. Fawcett, M.B.; R. J. Gladstone, M.D.; T. Wardrop Griffith, M.D.; G. B. Howes, LL.D., F.R.S.; A. Keith, M.D.; C. B. Lockwood; A. Macalister, M.D., F.R.S.; J. Musgrove, M.D.; C. J. Patten, M.D.; W. G. Ridewood, D.Sc.; Arthur Robinson, M.D.; G. D. Thane; H. J. Waring, M.S.; B. C. A. Windle, M.D., F.R.S.; A. H. Young, M.B.

The newly-elected President then took the chair, and a vote of thanks to the outgoing President was proposed by Prof. J. Symington, seconded by Prof. Alex. Macalister, and carried with acclamation.

Dr A. Keith (on behalf of the Hon. Treasurer, Prof. G. B. Howes) submitted the balance-sheet for the year. In his report he referred to the financial condition of the Society, and pointed out that the balance of £55, 14s. 2d. must be considered as very satisfactory.

It was then proposed from the chair, seconded by Mr C. B. Lockwood, and carried unanimously, "that the best thanks of the Society be accorded to Prof. G. B. Howes for the long and valued services which he has rendered in the capacity of Honorary Treasurer."

The following gentlemen, recommended by the Committee of Management, were unanimously elected members of the Society:— David Waterston, M.A., M.D., Demonstrator of Anatomy, University of Edinburgh, proposed by Sir William Turner, K.C.B., D. J. Cunningham, D. Hepburn. Claude Saberton, M.B., Ch.B., Demonstrator of Anatomy, The Victoria University of Manchester, proposed by A. H. Young, Peter Thompson, Arthur Robinson. Evelyn John Evatt, M.B., Demonstrator of Anatomy, University College, Cardiff, proposed by A. Thomson, A. Frazer, A. F. Dixon. H. S. Clogg, M.B., M.S., F.R.C.S., Assistant Surgeon and Demonstrator of Anatomy, Charing Cross Hospital, proposed by C. Addison, F. G. Parsons, A. Keith. Sydney R. Scott, F.R.C.S., 44 Welbeck Street, Cavendish Square, W., proposed by C. B. Lockwood, F. G. Parsons, Peter Thompson. William Thorburn, B.S., F.R.C.S., 2 St Peter's Square, Manchester, proposed by A. H. Young, Arthur Robinson, Peter Thompson. F. H. Westmacott, F.R.C.S., 8 St John Street, Manchester, proposed by A. H. Young, Arthur Robinson, Peter Thompson. Wilfred Harris, M.D., M.R.C.P., Medical Tutor, St Mary's Hospital, proposed by F. Jaffrey, Peter Thompson, R. J. Gladstone.

The following papers were next brought before the Society:—

(1) Mr F. G. Parsons.—"On the Nature of certain Epiphyses." This paper will be published *in extenso* in an early number of the *Journal of Anatomy and Physiology*.

(2) *The Meaning of the Expansions of the Gracilis and Semitendinosus.* By F. G. Parsons.

As is well known, the tendons of insertion of the semitendinosus and gracilis in man have fibrous expansions which run some little way down the leg and are finally lost in the fascia. I have never heard any explanation given for these, although they are very constant, and it is only lately that a possible interpretation of them has struck me. In dissecting most of the lower mammals, one cannot fail to notice that the semitendinosus, gracilis, and biceps send off important fascial expansions which run down to the tuberosity of the calcaneum and blend with one another to form a sheath for the tendo Achillis. They have been casually noticed by most writers on

comparative myology, but I think that they were first carefully described by Prof. Windle. It is only lately, in dissecting and condensing the literature of the muscles of ungulates, that the anatomist just named and I noticed that this sheath was better developed in that order than in any other, and I have little doubt that the expansions found in man are the remains of such a sheath. Originally these expansions represent probably a longitudinal set of muscle fibres running from the pelvis to the foot, such as one meets with in the caudo-pedal muscle of reptiles, though it is difficult, even if space permitted, to discuss the homologies of the reptilian and mammalian musculature of the leg. One may, however, fairly inquire why these expansions should reach their maximum in the ungulates, and whether there is anything peculiar in the physiology of the hind limbs of these animals which might account for their strong development.

As an order the ungulates are strictly cursorial, and their hind limbs are specialised for walking, running, and standing. The hippopotamus and water cherrotain are the only species which may be called aquatic; the tree hyrax is the only arboreal form; while none are really fossorial. It is therefore, I think, fair to expect that any arrangement of limb muscles which is seen at its best in them will be such as to afford them the greatest convenience in running. In ungulates and other cursorial animals the function of the hind limb is to first pull and then push the body over the spot on which the foot is planted; in order to do this, the hip is extended and the knee slightly flexed, while the ankle is strongly plantar flexed, and this latter is perhaps the most important part of the whole movement of progression. It is obvious that the expansions of the hamstring muscles to the calcaneum will strongly help in the plantar flexion of the ankle, at the same time that the hamstrings themselves are slightly flexing the knee. In man, with his straight leg and erect posture, the mechanism of progression has been much modified, and the expansions are no longer used, still they persist as vestiges in the gracilis and semitendinosus; while in the biceps they are occasionally found.

### (3) *Notes on the Eyebrows of Man.* By Walter Kidd.

The eyebrows of old or elderly persons frequently exhibit certain striking changes, and their interpretation is not without interest. There are two classes of phenomena to which attention may be directed—*changes in the normal direction of the hairs*, and *wrinkles* in the skin of the frontal region.

*Normal arrangement of eyebrow.*—The normal arrangement of the hair on the eyebrows of a moderately hairy subject is as follows: In the middle line the hairs of the two sides tend to meet and form a somewhat confused group of hairs; passing away from the middle line, the hairs assume a nearly sagittal direction, then become more sloped away, and a sharp change in the direction of the frontal and orbital streams brings the remaining hairs into that regular accurate

arrangement of a united stream so characteristic of a hairy subject, and this passes along the superciliary ridge to the external angular process. In a hairy young subject there is very often seen a break in the stream, which is situated close to the inner end of the eyebrow, at about the junction of the inner sixth with the outer five-sixths of the whole stream. This small definite gap is referred to in a former paper read before this society.[1] The normal arrangement cannot well be followed unless the subject be young and hairy. Normally the hairs lie close along the skin, as in other parts, but as middle life advances they tend to share in the general thickening and stiffening of the hair which takes place, and they often grow very long, and project more from the surface than in young subjects.

*Four modifications.*—Four clearly-defined modifications occur :—

1. The general plane of the hairs becomes projected from that of the skin.

2. The break or gap referred to becomes well marked, and the hairs on each side of it stand out considerably from the surface.

3. At the junction of the outer and middle third of the eyebrow a bunch of long stiff hairs is often found projecting nearly or quite at a right angle from the skin, and resembling the points of a small moustache. This is so marked in some elderly men, and occasionally in women, that I have found it measure as much as an inch, and frequently half an inch, from the skin to the points.

4. The stream of hair not only projects generally from the plane of the eyebrow, but in some subjects trends markedly in the frontal, and in others in the orbital, direction, in the latter case lying like a small curtain over the upper eyelid in certain old persons with bushy eyebrows. These two changes are much more marked towards the temporal side of the eyebrow than elsewhere. In certain lower animals there are found similar projecting bunches of hair on the eyebrow, *e.g.* in Cervidæ, Antilopidæ, Giraffa Capensis, and Somalicus. It also seems probable that the long hairs noted by Darwin[2] in the eyebrows of certain persons, and which he traces back to Macaci and Chimpanzees, are allied to or identical with those here described in the case of elderly persons. I hope to show that the latter are not inherited from the lower animals, and consequently not vestigial.

*Wrinkles.*—The second group of phenomena considered here are the wrinkles nearly always found in the skin of the frontal region in elderly subjects. They are mainly of two kinds, *sagittal* and *arched*, or nearly horizontal. The former appear as one deep central, or two nearly symmetrical lateral grooves. The arched wrinkles are situated in a series of rows over the whole frontal region, except where the angle between the two frontalis muscles is found, and are deeper and better defined over the outer third or half of this region, and towards the temporal crest they descend, keeping rather closely to the outline of the orbit.

*Interpretation.*—It would not be worth while to bring forward these simple points of superficial anatomy, except for the interpretation which one may find for them, and this is of some use in other parts

[1] November 1901. [2] *Descent of Man*, p. 19.

and other animals than man for the understanding of the ætiology of the hair-streams and their modifications.

There are certain mechanical causes to which these phenomena are evidently due, and they are nearly constantly at work in the lifetime of an individual, except during sleep. I refer to the reflex contractions of the frontalis, corrugator supercilii, and orbicularis muscles, in the various actions of knitting, elevating, and depressing the eyebrows, the last of these being caused by the action of the upper half of the orbital part of the orbicularis, which stretches the skin and opposes the frontalis; the two former by the actions of the corrugator supercilii and frontalis. There is thus a congeries of lines of traction surrounding this insignificant stream of hair on the eyebrow of man, and a set of forces in very frequent action under the influences of cerebral action and reflex movements of the lids. The results are seen in wrinkles in elderly persons, and thus are stereotyped in different subjects the particular muscular action or actions which have predominated through life. A person with well-defined sagittal wrinkles shows very faint arched wrinkles, if any, and, *vice versâ*, a person with marked arched wrinkles over the outer part of the eyebrows descending towards the malar prominence shows a smooth surface between the two inner extremities of the eyebrows. A person whose general stream of hair on the eyebrows turns upwards and outwards in middle life shows scanty sagittal wrinkles, and another whose stream of hair is directed towards the orbit has marked sagittal and ill-defined arched wrinkles. Wrinkles, then, are graphic representations of the fact that in one the corrugator, in another the frontalis, and in a third the orbicularis, has had the best of it in this little field of muscular action. The reasons for these differences must be sought in the mental characteristics and occupations predominant in the individual.

*Direction of hairs altered by muscular action.*—The facts here mentioned show that the normal direction of the hairs is altered by often-repeated traction on the skin underlying long stiff hairs. In extreme cases the hairs assume a position at right angles to the skin, and in this point they resemble the eyelashes, which are the only other instances of hair set at a right angle to the surface.

*Break or gap in eyebrows.*—In addition to these facts and their interpretation, there is an allied matter which requires more detailed attention. In the course of examining numerous persons who showed the small break in the stream of the eyebrow already described, it seemed necessary to seek for some explanation of its occurrence, for there is nothing in the contour of the superciliary ridge which should prevent the hairs from lying evenly along it, from near the median line to the external angular process. The facts of the arrangements of the muscles here underlying and attached to the skin suggest a very obvious reason for the break or gap described. The thick corrugator muscle attached to the under surface of the deep soft parts near the middle of the eyebrow affords just the kind of traction which is calculated to disturb the normal and uniform stream of hair at the spot where the break is actually found in a young hairy

subject. A particular case of a young girl aged 13 with rather bushy eyebrows showed not only the division in the hair-stream, but also the hairs at the outer side of the gap twisted away from the general stream and projecting in a small bunch from the level of the skin.

*Preponderance on left side.*—Another point which came out in the course of observing these facts in young subjects was that a singularly large number of them showed the break on the left side and not on the right, or manifestly more marked on the left than the right side. Accordingly, I noted 200 consecutive cases in which this phenomenon was present, with the following results :—

| | | | |
|---|---|---|---|
| 14 | showed the break | more on the right side. |
| 33 | ,, | ,, | equally on both sides. |
| 153 | ,, | ,, | more on the left side. |

Thus 76·5 per cent. of these were cases in which the left-sided break decidedly preponderated. This fact is in keeping with a much larger number of instances of which I did not keep notes, and is singular enough to need some explanation. It is clearly not accidental, and it is difficult to see any other than a mechanical cause for it. The following considerations seem to throw some light upon it :—

1. The break is probably caused by the persistent traction of the corrugator on the skin.

2. In the actions of reading and writing, as practised in all countries except China, the head of the reader or writer is necessarily inclined rather to the left than the right side, on account of the custom of writing from left to right and from the top to the bottom of the page. This attitude would seem to put more strain upon the corrugator of the left side than that of the right.

3. In these two actions concentration of the attention and of the eyes leads to persistent knitting of the brows in most persons.

4. The reflex partial closure of the lids in strong light also produces knitting of the brows.

It would seem probable that there is a slight preponderance of action to be looked for in the muscles of the left side, and that thus the one-sided phenomenon is produced.

It may be asked what is the effect on the eyebrows of the Chinese of their habit of reading and writing from right to left and from below upwards. This investigation might afford a useful 'experiment of the finger-post' if evidence were forthcoming, and I have made inquiries among medical men in China as to the incidence of this little break in the eyebrow on one or the other side, among the educated classes, but hitherto I have been unable to get any evidence on the point. I suspect that it will not be possible to obtain evidence for or against the view here put forward, for the reason that the thin and shorter Mongolian eyebrows, with wide bare space between, do not possess the close hair or the arrangement of hairs just at the critical point where the corrugator exercises its traction, and thus no break can be produced.

I may add that I have examined two separate individuals in whom

disease had opportunely made a simple experiment, so to speak, on this point. They were both young persons, with right hemiplegia due to infantile paralysis, and both were in the habit of writing with their left hands, and both had occupations which involved a good deal of writing. In these two persons the break in the stream of the eyebrow was marked on the right side and not on the left. I give these two instances, *quantum valeant*; but at any rate they are not opposed to the theory here put forward.

As far as observation has gone, none of the phenomena here referred to have been found to be congenital.

(4) *Anatomical Evidence as to the Nature of the Cæcum and Appendix.* By Arthur Keith, M.D., F.R.C.S., Lecturer on Anatomy, London Hospital Medical College.

The purpose of this paper is to bring forward evidence to support the following statements relating to the nature of the ileo-cæcal region of the bowel.

(1) That the ileo-cæcal junction is guarded by a muscular sphincter which has two purposes: (1) to regulate the flow of the bowel contents from the ileum into the cæcum; (2) to prevent any regurgitation of the contents of the cæcum into the ileum. In this, its second function, the ileo-cæcal orifice may be aided by its lips being arranged to serve, more or less effectively, as a mechanical valve.

(2) That there is in man and in all air-breathing vertebrates which live on a mixed or vegetable diet, a certain tract of the ascending colon in which the circular muscle coat is well developed and acts as a sphincter for the cæcum, regulating the escape of the cæcal contents. The muscular coat of this short part of the ascending colon, lying on the upper part of the iliac fossa in man, may be named the *cæco-colic sphincter*.

(3) In order to leave undisturbed our present definition of cæcum, as "that part of the colon below the ileo-cæcal orifice," or, in an embryological sense, "that part of the colon which is developed as a cæcal outgrowth," and yet to indicate clearly that the cæcum with its appendix is united in function with that part of the colon which lies below the cæco-colic sphincter, I propose that the term *caput coli* be given to that part of the colon which extends from the cæcal apex to the cæco-colic sphincter. Thus the caput coli is made up of two compartments—a *primary*, represented by the cæcal part of the colon, a part which is never absent, and stretches from the ileo-cæcal orifice to the cæco-colic sphincter; and a *secondary* compartment, the cæcum and appendix, which may be much modified or absent.

(4) That the cæcum is separated from the cæcal part of the colon by muscular bands—represented in man by the frenula of the ileo-cæcal valve—which regulate the passage of the contents from one compartment of the caput coli to the other.

(5) That the caput coli corresponds to the stomach functionally, embryologically, and anatomically. It stands in the same relation-

ship to the great bowel as the stomach does to the small bowel. In some genera the stomach, in other genera the caput coli, is the main organ of digestion.[1] There is an anatomical and functional correlation between the cardiac part of the stomach and the cæcum.

*The ileo-cæcal junction.*—If the contents be washed out of the ileo-cæcal tract of the bowel, while its normal peritoneal relationships within the body are retained intact, and paraffin wax, at the boiling-point of water, be injected through the ileum so as to nearly fill the cæcum, it will be found that the wax within the ileum will be sharply nipped off from that within the cæcum, at the free margin of the ileo-cæcal valve. This effect is best seen in the bowels of animals such as the cat, in which the ileo-cæcal junction has no valvular arrangement.

The manner in which the closure is produced may be seen by a

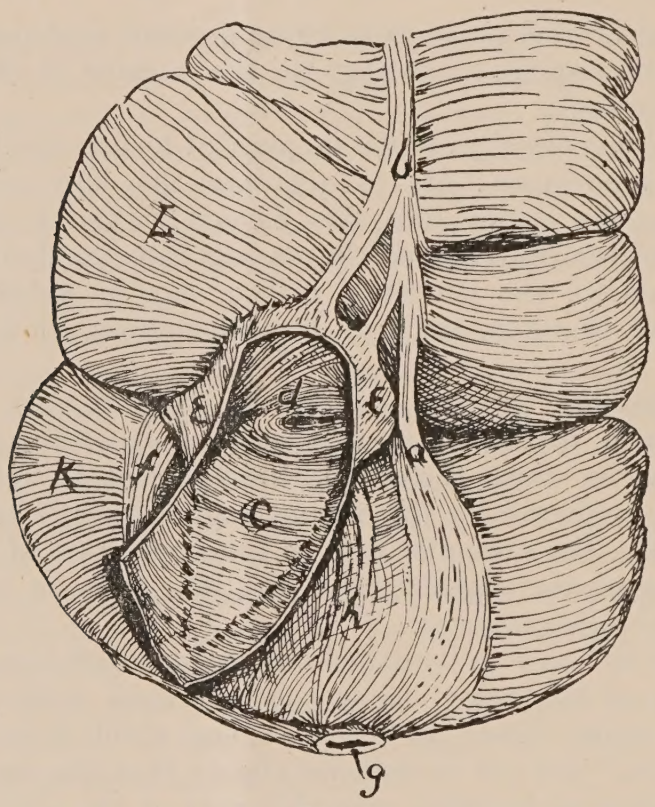


FIG. 1.

reference to fig. 1. That figure represents a human cæcum into which wax was thrown as described above. The wax has been removed from the terminal part of the ileum by cutting away the mesenteric half of that part of the bowel. When the mucous membrane is then removed, the arrangement of the ileo-cæcal musculature is well seen. The following three points should be noted: (1) That the fibres immediately surrounding the ileo-cæcal orifice form a series of racquet-shaped loops which, springing from

[1] See the evidence produced by Owen in vol. iii. of *The Comparative Anatomy and Physiology of the Vertebrates.* Since then many more facts have come to light showing that the fundus of the stomach and cæcum may assume vicariously the function of the other.

the posterior frenulum, encircle the anterior angle of the orifice, and return to end in the posterior frenulum. The posterior frenulum is the basis from which these fibres act. When these fibres are thrown into a heat contraction by the use of hot wax, the anterior margin of the orifice is drawn backwards; the mucous membrane is thrown into folds which occlude the orifice. (2) In the upper ileo-cæcal valve the muscular fibres that enter it from the anterior and posterior frenula decussate. This decussation is especially marked at the attached margin of the valve, and forms a functional boundary between the fibres of the cæcum on the one hand, and the fibres which regulate and guard the orifice on the other. (3) The lower valve is seen to form what may be termed the "floor" of the terminal part of the ileum. Thus seen (fig. 1) the lower valve is triangular in shape, and contains fibres derived from and continuous with fibres of the ileum and cæcum. But at the attached margins of the valve (see fig. 1) the muscular fibres interdigitate, and by that interdigitation a physiological differentiation between the musculature in the valve and that in the ileum and cæcum is effected.

*The terminal part of the ileum.*—Symington and Birmingham have given descriptions of the oblique manner in which the ileum enters the cæcum, and of the valvular advantage derived therefrom. The ileum has two borders—a fixed or mesenteric, a free or anti-mesenteric. The peculiarity of the terminal part of the ileum (3 cm. in length when relaxed) is that the free border fuses with adjacent side of the ileum to form the lower ileo-cæcal valve; the circular muscular fibres on the mesenteric aspect of the terminal part of the ileum form a series of horseshoe-shaped loops, which, acting on the lower ileo-cæcal valve as a foot-plate, can advantageously squeeze the "contents" of the terminal part of the ileum within the cæcum (figs. 1 and 2). In most vertebrates the terminal part of the ileum is thus differentiated. The fibres of the mesentery are so attached to this part of the ileum as to allow its easy expansion and contraction.

*The union of the muscular fibres of the ileum and cæcum.*—It is usually said that the longitudinal fibres of the ileum end directly in those of the cæcum, but a close investigation will show that only a few of them have such a termination. Most of the longitudinal fibres of the ileum, especially on its attached and free borders, end in fibrous tissue, continuous with that forming the basis of the ileo-cæcal valves. On the anterior and posterior aspects of the ileum the longitudinal fibres end by passing beneath the longitudinal fibres of the cæcum. Only a comparatively few join the longitudinal fibres of the cæcum (fig. 2).

The ileo-cæcal valves contain fibres continuous with the circular fibres of the ileum and cæcum, but at the attached margins of the valves these fibres so interdigitate that there is a real functional differentiation between the muscular fibres of the ileum, the muscular fibres of the cæcum, and those within the ileo-cæcal valves.

The less the ileo-cæcal junction assumes the shape of a mechanical valve (in no animal does it serve as a competent mechanical valve),

the greater is the development of circular fibres round the ileo-cæcal orifice, which serve purely the purpose of a sphincter.

*The ileo-cæcal fold* (*bloodless fold of Treves*).—Certain of the longitudinal muscular fibres on the free border of the ileum pass into this fold and end on the cæcum. The fold commences at the apex of the lower ileo-cæcal valve. This fold assists to maintain the oblique junction of the ileum and cæcum. The mesentery of the appendix, the anterior cæcal fold, and the ileo-cæcal fold, are, all three of them, originally fused together in the common tissue of the mesentery. In many reptilian forms—especially tortoises—the three folds remain undifferentiated from the mesentery. They are differentiated by the formation of the ileo-cæcal and ileo-colic fossæ.

*What regulates the opening and closing of the ileo-cæcal orifice?*—

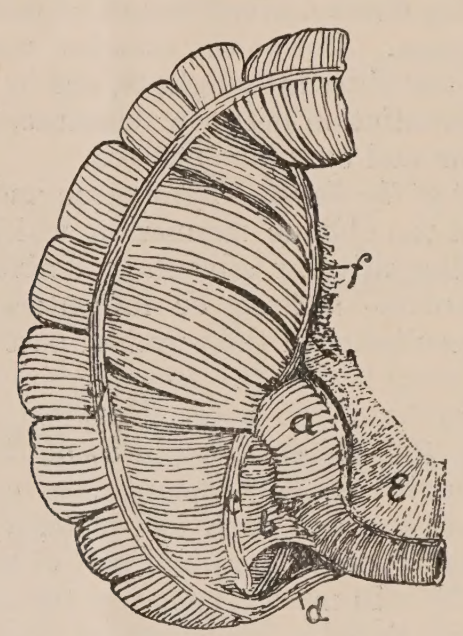


Fig. 2.

The ileo-cæcal sphincter is the only feature that is constantly seen at the junction of the small and great bowel. The cæcum is absent in many genera of vertebrates[1]; but excepting certain groups of fishes, I do not know of any member of the vertebrate series in which there is not a well-marked differentiation in thickness of the muscular coats at the ileo-colic junction. The cæcum may be partially or completely absent, but the presence of an ileo-cæcal sphincter appears to be a necessity for the welfare of the individual.

One would expect, arguing from the work of Pawlow's pupils, and that of Starling and Bayliss, on the mechanism of the pyloric sphincter, that the condition of the contents of the cæcum and appendix would determine the relaxation of the ileo-colic sphincter and the discharge of the contents of the ileum into the cæcum. In mice, I found that the contents of the cæcum showed the same neutral reaction as those of the ileum; occasionally the contents of

[1] The cæcum may be absent in man. See a case described by Prof. Elliot Smith, *Jour. of Anat. and Phys.*, October 1903.

the cæcum showed a decided acid reaction. When the contents of the cæcum were rendered acid in reaction by the injection of a solution of acetic acid, or alkaline by the injection of a solution of carbonate of soda, the effect on the ileo-cæcal orifice was found to be irregular; probably this was owing to the fact that the experiments had to be performed on animals just put to death by chloroform. Thus the stimulus or stimuli which lead to the relaxation of the ileo-cæcal orifice and the filling and emptying of the cæcum I had to leave undiscovered; their discovery would certainly greatly aid one in the interpretation of the anatomical details of the ileo-cæcal region.

*The nervous mechanism of the ileo-cæcal orifice.*—The ileo-cæcal sphincter, like the muscle which guards the exit of other hollow viscera, such as the stomach, bladder, and rectum, is normally in a

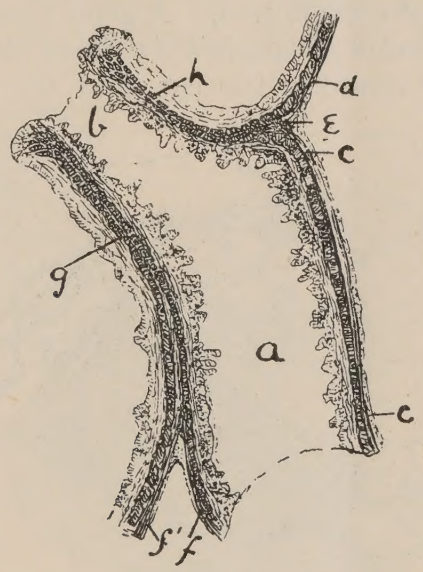


FIG. 3.

condition of contraction. Examination of a great number of mice in which digestion had proceeded to every stage, convinces one of that. In the living human body the upper part of the cæcum can be percussed out, owing to the gas it contains; unless the ileo-cæcal sphincter were in action the gaseous contents of the cæcum could not be retained. Sée and Mathieu[1] have pointed out, and I think rightly, that deep pressure over the pyloric orifice of the stomach elicits a peculiar tenderness; a similar tenderness can be elicited over the ileo-cæcal orifice.[2] Both orifices are apparently furnished with a similar nervous mechanism. Mr James Sherren[3] finds that there is no superficial or skin tenderness connected with any part of the bowel between the duodenum and the appendix. In the duodenum arises the reflex that opens the pylorus; in the cæcum and appendix *probably* arises the reflex that opens the ileo-cæcal orifice. The duodenum is connected with the ninth dorsal segment; the appendix with the eleventh.

[1] "De la dilatation atonique de l'estomac," *Revue de Médecine*, Mai et Sept. 1884.

[2] *Brit. Med. Jour.*, June 1901.

[3] *Lancet*, Sept. 19, 1903.

*The cæco-colic sphincter.*—While working at mice, I was struck by the constancy with which a certain segment of the ascending colon appeared in a contracted condition. Except when the cæcum was actively discharging its contents, this segment never relaxed; its relaxation was then only temporary. In looking into the condition of the ascending colon throughout the vertebrate kingdom in such reptiles, birds, and mammals as feed on a vegetable or mixed diet, I was struck by the thickness of the circular muscular coat, the contracted condition of that coat, and the narrowness of the lumen of the gut some little distance beyond the ileo-cæcal junction. Examples are shown in figs. 4, 5, 6, of the various forms in which this sphincter occurs. In human bodies preserved by formalin, a substance that causes a peculiar contraction of muscular tissue, the commencing segment of the ascending colon is contracted in 90 per cent. of the cases I have examined. A good example may be seen in the splanchnology volume of *Quain's Anatomy* (tenth edition), p. 109.

Dr W. B. Cannon[1] found in the cat that the antiperistaltic wave

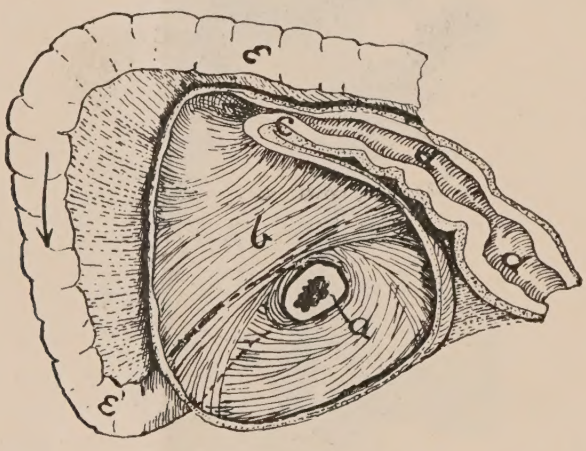

Fig. 4.

which filled the cæcum started at the distal end of the transverse colon. Dr Barclay Smith[2] observed in the rat that the antiperistaltic wave commenced some distance distal to the point at which I had placed the cæco-colic in that animal. Yet the condition which I constantly saw in mice, especially in animals which had eaten no food four hours or more before death, and in mice in which the contents of the ileum were being emptied into the cæcum, demonstrated, I think, that the circular fibres of a segment near the commencement of the colon acted as a sphincter to the *caput coli*, and regulated the escape of its contents. In the living human body, too, it will be found that while the cæcum is resonant and contains air, that part of the ascending colon which can be percussed along the crest of the right ileum gives a dull note, evidently preventing the escape of gas from the cæcum. There are very few vegetable-feeding vertebrates that do not show a clear indication of a cæco-colic functional sphincter.

[1] *The American Journal of Physiology*, vol. vi. 1903, p. 251.

[2] *Proceedings of the Cambridge Philosophical Society*, vol. xii. part 1, 1903.

*The cæcal colon.*—There are about twenty-five genera of mammals which possess no cæcum, yet if these genera be examined it will be found that the commencement of the colon is separated by the ileo-cæcal sphincter from the ileum on the one hand, and commonly by a more or less demarcated cæco-colic sphincter from the remainder of the colon on the other. In Procyon, which may be taken as a typical *acæcal* genus, these two sphincters are well developed. The tract of colon between these two sphincters may be called the *cæcal colon*, for when the cæcum is present it is from this segment of the colon that it is developed. The cæcal colon is well marked in birds (fig. 6); the two cæca open into it by a common mouth; in the tortoise it forms part of the cæcum (fig. 4); in rodents it is separated from the cæcum by a special sphincter (fig. 5). In man it is separated from the cæcum by the retinacula of the ileo-cæcal valve. In most, if not in all mammals, the contents of the ileum pass, not into the cæcum, but into the cæcal colon. Dr W. B. Cannon found

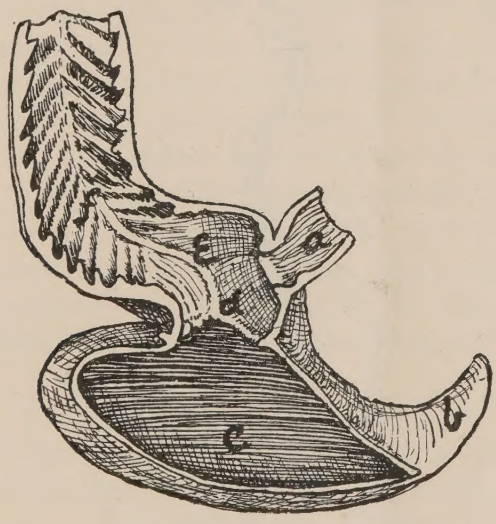

Fig. 5.

in the cat, and Dr Barclay Smith in the rat, that the contents of the ileum passed some way into the colon, distal to the cæcal colon, before they were forced backwards into the cæcum by an anti-peristaltic wave. The anatomical evidence at my disposal leads me to believe that the contents of the ileum, after reaching the cæcal colon, are passed by that segment into the cæcum. In short, the cæcal colon acts as the antrum and feeder of the colon. In some herbivorous mammals this segment of the colon undergoes an extraordinary development, being thrown into a series of spirals.

*The sphincter of the cæcum.*—This is seen in its most typical form in birds (see fig. 6). The two cæca open within the cæcal colon by a common orifice, surrounded by circular muscular fibres which regulate the entrance and exit of the cæcal contents. In rodents (fig. 5), in the dog, and in many mammalian forms, it forms a well-developed circular belt surrounding the entrance of the cæcum into the cæcal colon. In such forms the ileum appears to enter the cæcal colon. In man the sphincter of the cæcum is represented by the frenula of the ileo-

cacal valve, the ileum appearing to enter the border line between the cæcum and cæcal colon.

*Comparison of the stomach and caput coli.*—

(a) *Their divisions or compartments.*—To Everard Home [1] must be given the credit of having produced good evidence that the stomachs of all mammals, if not of all vertebrates, were divided during active digestion into two compartments by a constricting band of muscle. That sphincter or constrictor may be sharply demarcated, as in rodents, or diffuse and less distinctly circumscribed, as in Primates and the Carnivora. The mid-gastric sphincter is comparable to the sphincter of the cæcum.

(b) *In development* the fundus of the stomach is comparable to

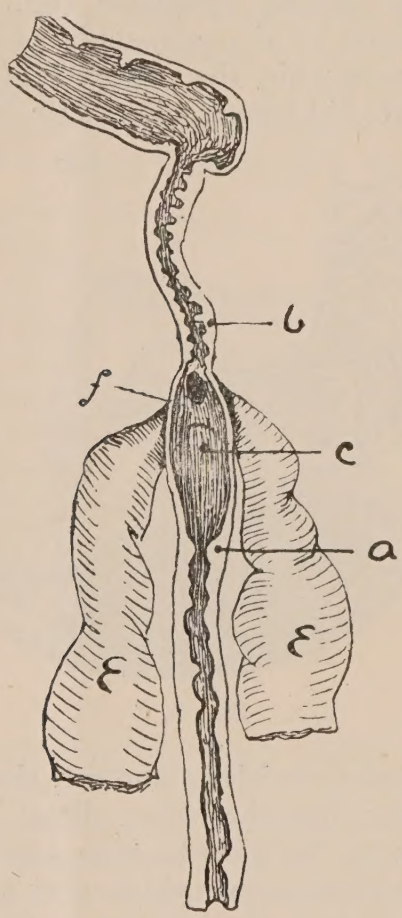


FIG. 6.

the cæcum and appendix.[2] Both represent cæcal outgrowths from a definite segment of the gut. Each develops a greater or less amount of lymphoid tissue into mucous and submucous coats. In animals like the pig, tapir, and dugong, the fundus of the stomach is prolonged into a cæcal apex. Such an apex is seen in the human stomach during the third and fourth months of fœtal life.

(c) *Functionally* the fundus of the stomach and cæcum have much in common. From both we know that water is freely absorbed. An

[1] *Lectures on Comparative Anatomy*, London, 1814.

[2] A. Keith and F. W. Jones, *Proc. Anat. Soc. Great Britain and Ireland*, Nov. 1901, p. xxiv.

experiment of Everard Home's which throws light on this has been allowed to drop into oblivion. On taking tincture of rhubarb, he found rhubarb freely recognisable in his urine for about an hour after taking the tincture; it then disappeared from his urine for about three hours, when it again appeared. Now that is just the period of time usually taken by the contents of the stomach to reach the great intestine. Absorption of rhubarb again set in, probably from the cæcum. Further, the food undergoes an attrition in the fundus of the stomach; the contents of the cæcum are more finely divided than those of the ileum. In vegetable-feeding mammals the cæcum is never completely emptied; a remnant is left, for what purpose I cannot say for certain, but probably to set up the necessary fermentation when the cæcum is again filled. Everard Home found that the paunch of the ox, even if it had not tasted food for over a week, still contained a complement of unruminated food; the purpose here is probably similar—to set up the normal fermentation.

(d) *The entrance and exit to the cæcum and stomach are guarded similarly.*—Rightly regarded, the œsophagus is a sphincter, drawn out and greatly extended by the development of the thorax. Like all sphincters, it is in a condition of tonic contraction, being inhibited only when in action. The terminal part of the ileum and ileo-cæcal sphincters stand in the same relationship to the cæcum as the œsophagus to the stomach. The œsophagus may enter to the right of the mid-gastric sphincter as in the Cape mole, or to the left of it as in the hare or rabbit. Similarly, the ileum may enter above or below the cæcal sphincter. The contents of the muscular stomach require a strong pyloric sphincter; the weaker cæcum is less strongly guarded.

(e) *The stomach and cæcum are constructed on the same principle,* viz., each has a short fixed curvature and a great and movable curvature. The circular fibres act with advantage from the lesser curvature; by merely contracting and drawing the greater towards the lesser curvature, the viscus is necessarily shortened. In the cæcum the longitudinal fibres are for the greater part aggregated into three bands: one, the shortest, and partly fibrous in the adult, lies at the attachment of the mesentery along the lesser curvature; the other two lie in front and behind the greater curvature. In the cardiac part of the stomach of the kangaroo, the longitudinal fibres have a similar arrangement. The oblique fibres of the fundus of the stomach correspond to the circular fibres of the cæcum and appendix.[1]

*Movements of the cæcum.*—One could never guess from a mere study of the musculature of the cæcum the extraordinary transformation through which this viscus passes during cæcal digestion. Dr Cannon, when studying the intestinal movements of the cat by means of bismuth and X-rays, concluded that all removements could be reduced to two: a *peristaltic* movement by means of which the contents are urged onwards, and a *dividing* or segmenting movement—evidently connected with digestion and absorption. No doubt

[1] See Birmingham's figures of the musculature of the stomach, *Text-Book of Anatomy*, edited by D. J. Cunningham, p. 1008.

these movements are shared by the cæcum; but when one watches this viscus in the mouse or rat, certain very characteristic changes are seen to take place. At one time the ileum and colon will appear directly continuous, the cæcum being cut off by the cæcal sphincter; at another, the ileum will be seen to be united and continuous with the cæcum, and the cæcal part of the colon is cut off; at another, the cæcum and cæcal colon are continuous, the ileum being shut off by the ileo-cæcal sphincter; at another, and this is the movement I wish to direct attention to, the ileum enters and the colon leaves the *caput coli*, side by side. The band which produces the approximation of the ileum and cæcum is that which corresponds to the mesenteric tænia on the short curvature of the human cæcum.

*Intussusception of the ileo-cæcal tract.*—No explanation has ever been offered, so far as I am aware, of the frequency with which intussusceptions occur in this region of the intestine. Four forms are well known: (*a*) that in which the ileo-cæcal valve forms the apex of the intussuscepted segment; (*b*) that in which the invested fundus of the cæcum forms the apex; (*c*) that in which the cæcal sphincter (represented by the frenula of the ileo-cæcal valve) forms the apex; (*d*) that in which the cæco-colic sphincter forms the apex. Two factors have to be considered: (1) at the junction of the ileum and colon two waves meet—the antiperistaltic wave of the colon and the ordinary forward peristaltic movements of the ileum and cæcum; (2) the constrictor bands or sphincters naturally cause marked narrowings, which form the commencing points of invagination. In forcibly emptying itself, the cæcum may become invaginated; such an accident not unfrequently befalls a Meckel's diverticulum.

*What is the functional meaning of an appendix vermiformis?*—Did we know the exact function of the cæcum and cæcal apex, it would be easy to explain the various forms in which these parts of the intestine are found. At present we grope in the dark; we have not even a good working theory of the function of the cæcum and appendix. It is to meet this want that I bring forward the following hypothesis.

1. The first point to be settled is:

*What is the function of the lymphoid tissue*, which occurs so abundantly as solitary follicles and Peyer's patches in the great intestine and ileum of all mammals? The lymphoid tissue of the intestine represents to Metschnikoff[1] leucocytic armies to preserve the body from invasion by the fauna of micro-organisms which produce the digestive fermentation that normally takes place in the great intestine. Independently, Dr Barclay Smith[2] came to a similar conclusion, and both authors agree that the large intestine is a useless and dangerous viscus.

I found in the mouse that bacteria were extremely abundant in the ileum, cæcum, and colon, and their distribution roughly agreed with that of the abundance of lymphoid tissue. The lymphocytes

[1] *The Nature of Man*, English translation by Dr P. Chalmers Mitchell. London, 1903.

[2] *Proc. Cambridge Phil. Soc.*, vol. xii. part 1, 1903.

which abound in the lymphoid tissue of the gut may have a phagocytic power, but that function is secondary to the part they play in digestion. Judging from my own specimens, I do not think that the statements made by Gulland and by Klaatsch can be called in question—viz., that the lymphocytes of the solitary follicles and of Peyer's patches are derived from the epithelium lining the gut. Accepting that as an embryological fact, then I think it a legitimate inference that the lymphocytes will possess all the functional properties of the intestinal epithelium with the advantage that they can be transported in the lymph stream. Dr R. J. Berry observed that lymphoid tissue was developed in the cæcum and cæcal apex during the first week after birth; they may appear merely for protective purposes, but if they play a part in digestion, then they are necessary in the digestion of a mixed food such as milk. Yet lymphoid tissue is most abundant in mixed and vegetable feeders. Everard Home found a considerable percentage of fat in the cæca of ducks, but none in the terminal part of the colon. The following simple experiment also throws some light on the function of the great intestine. If on an ordinary microscopic slide there be placed side by side, six small samples taken from the intestine of a mouse two hours after a meal of oats, one each from the jejunum, ileum, cæcal apex, cæcum, transverse colon and descending colon, and treated with iodine—

The contents from the jejunum show a milky fluid and give instantly a profuse fine starch reaction.

The contents from ileum are coarsely granular; possess no milky fluid; *give no starch reaction.*

The contents from the cæcum, cæcal apex and ascending colon are more finely divided than from the ileum; are mixed with fluid débris; *give no starch reaction.*

The contents from descending colon show a fluid débris; give after a time starch reaction; starch particles are very large.

Evidently the intestinal contents in passing through the ileum and great intestine have become finely divided, the cellulose coverings have become dissolved, thus exposing the starch again to digestive fluids.

Arguing from the escape of leucocytes from the tonsil, it seemed to me possible that the lymphocytes might pass within the lumen of the gut, and act directly on the intestinal contents, but of that I failed to find any evidence on examination.

The active contraction of the muscular coat of the intestine appears to be a condition necessary to absorption. Prof. Mall has pointed out that with each contraction of the muscular coat of the bowel, blood and chyle are forced into the tributaries of the portal vein and lacteals.

If, then, one accepts as a working theory that the lymphoid tissue of the solitary follicles is a tissue concerned in digestion, and that absorption proceeds best under a strong muscular compression, then one can offer some explanation of the form, position, and structure of the appendix. Its strong muscular walls, narrow lumen, thick

carpet of solitary follicles set on wide lymph spaces, make it admirably adapted to such a form of digestion.[1] The great group of lymphatic glands situated in the mesentery at the angle between the ileum and colon, shows that a profuse absorption takes place from the appendix and cæcum. In anthropoids and in children, and in most adults, the contents of the cæcum pass freely into and from the appendix. From the fifth month of fœtal life onwards, Dr A. Low[2] found the appendix full of meconium. It seems to me probable that in the process of complete cæcal digestion all the food has to pass through the appendix.

In young anthropoids and in children the fundus of the cæcum tapers and gradually joins the appendix. When the years of active growth are over, the lymphoid follicles within the appendix, as is the case with all the lymphoid tissue of the body, become reduced in amount. During the early years of adult life, in the anthropoid as in man, the greater curvature of the cæcum is more and more developed while the lesser curvature becomes shorter; the position of the appendix becomes eccentric, and its demarcation from the cæcum more pronounced. The infantile form of cæcum is that best adapted for the filling of the appendix. The various forms of cæcum described by Treves are only well seen in a distended and relaxed condition of the viscus; in the contracted state the infantile form is still retained. It is just at that time of life when the lymphoid tissue is being reduced in amount and when the greater curvature of the cæcum is being produced, that human beings are most liable to inflammation and disease of the appendix.

*The relation of intestinal lymphoid tissue to the spleen.*—In making this investigation I was led to make some further observations on the nature of the intestinal lymphoid tissue and its relationship to the spleen. One has to account for the following facts: (1) Why the splenic blood enters the portal circulation; (2) why the spleen is so active during digestion; (3) its origin as a mesenteric gland; (4) the appearance of a leucocytosis when a proteid diet is taken by a person accustomed to a vegetable or mixed diet; (5) the origin of the leucocytes found in Peyer's patches and the solitary follicles from the hypoblast which lines the gut.

Now these facts can be accounted for by the following theory: that the lymphocytes are actively concerned in the absorption and distribution of food products, constituents chiefly contained in a vegetable diet; they have no amœboid power, and therefore enter the circulation by the lacteals and thoracic duct; they are picked out and broken up by the spleen. Hence the splenic blood is really portal blood. With a proteid and easily digested diet, the lymphocytes pass into the circulation in an empty condition and are allowed to pass through the spleen unchanged. In their investigation into digestive leucocytosis, Messrs Goodall, Gulland and Paton

[1] For a description of the lymphoid tissue, lymph spaces, and of the gaps in the muscular coat, see a paper by C. B. Lockwood, *Proc. Anat. Soc.*, Nov. 1899, p. ix.

[2] "The Relation of Meconium to the Fœtal Appendix," *Lancet*, 2nd May 1903, p. 1120.

confined their attention to the blood in the mesenteric artery and portal vein. They naturally found the lymphocytes as abundant in the one vessel as in the other, and came to the conclusion that the leucocytosis of digestion was not related to any activity in the intestinal lymphoid tissue.

I take this opportunity of acknowledging that this paper is largely based on the splendid collection of material exhibited on the shelves of the Museum of the Royal College of Surgeons of England. Although I cannot accept the classification of cæca framed by Prof. Huntington, I gladly acknowledge my indebtedness to his work.[1]

In the discussion which followed, Dr Barclay Smith criticised the methods whereby Dr Keith arrived at his conclusions. He had had some considerable experience in investigating the muscular mechanism of the large intestine in living animals, and he had come to the conclusion that—(1) The phenomena exhibited by the gut during the death stage were of an altogether different character from what might be regarded as the normal phenomena exhibited during life. (2) The condition of the gut after death was an absolutely fallacious criterion of its condition during life.

Mr Lockwood said he had examined histologically more than one hundred appendices, and could not agree that as age advanced the lymphoid follicles disappeared. On the contrary, he had seen them of full size and numerous up to the seventieth year.

## DESCRIPTION OF FIGURES IN TEXT.

Fig. 1. The musculature of the ileo-cæcal valves of the human cæcum exposed by opening the ileum. The orifice was previously contracted by the injection of hot wax.

*a.* Contracted and semi-fibrous part of mesenteric tænia of cæcum. It spans the depression over the posterior frenulum of the ileo-cæcal valve.
*b.* Fibres of mesenteric tænia springing from the ileo-cæcal junction.
*c.* Lower valve of the ileo-cæcal orifice, showing that it forms the floor of the terminal part of the ileum.
*d.* The loop-shaped inner fibres of the ileo-cæcal orifice.
*e.* Termination of the longitudinal fibres of the ileum.
*f.* Anterior longitudinal fibres of cæcum.
*g.* Appendix cut across.
*k.* Cæcum.
*l.* Cæcal colon.

Fig. 2. Anterior view of the ileo-cæcal junction, showing the manner in which the circular fibres of the terminal part of the ileum join the cæcum.

*a.* Circular fibres of ileum. A few of the longitudinal fibres are shown on the mesenteric border.
*b.* Longitudinal fibres running into the ileo-cæcal fold (bloodless fold of Treves).
*c.* Anterior longitudinal fibres of cæcum, beneath which longitudinal fibres of the ileum terminate.

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[1] *The Anatomy of the Human Peritoneum and Abdominal Cavity.* G. S. Huntington, M.D. London, 1903.

*d.* Root of appendix.
*e.* Mesentery. It is attached to the posterior aspect of the terminal segment of the ileum.
*f.* Mesenteric tænia.
*g.* Anterior tænia.

Fig. 3. Diagrammatic section of the ileo-cæcal junction of a child at full time.
*a.* Terminal part of ileum.
*b.* Ileo-cæcal orifice.
*cc.* Longitudinal fibres of ileum united with *d*, the fibrous tissue in the upper ileo-cæcal valve.
*ff.* Longitudinal fibres of ileum and cæcum uniting in fibrous tissue of the lower valve.
*gh.* Fibres continuous with the circular fibres of the cæcum and ileum.

Fig. 4. Ileum, cæcum and colon of a tortoise.
*a.* Ileo-cæcal orifice surrounded by circular fibres.
*b.* Further from orifice are seen transverse fibres representing the frenula of the ileo-cæcal valves of man.
*c.* Cæco-colic sphincter.
*dd.* Colon.
*ee.* Ileum.

Fig. 5. Ileo-cæcal region of mouse.
*a.* Termination of ileum, showing ileo-cæcal sphincter.
*b.* Cæcal apex.
*c.* Cæcum.
*d.* Sphincter of cæcum.
*e.* Cæcal colon—contracted.
*f.* Cæco-colic sphincter.

Fig. 6. Ileo-cæcal tract of young ostrich laid open along its mesenteric border.
*a.* Ileo-cæcal sphincter.
*b.* Cæco-colic sphincter.
*c.* Cæcal colon.
*ee.* Cæca.
*f.* Sphincter of cæca.

(5) Dr Wilfred Harris read a paper and showed several preparations to illustrate "the true form of the brachial plexus." This paper will be published *in extenso* in the April number of the *Journal of Anatomy and Physiology.*

(6) *On the Presence and Significance of the Superior Commissure throughout the Vertebrata.* By John Cameron, M.B. Edin., M.R.C.S. Eng.

From a study of embryos representing the five classes of the vertebrata it has been ascertained that the fibres of the superior commissure develop from the cells of the ganglia habenulæ, and connect the ganglia of opposite sides. In addition to these fibres there are others which emerge from the ganglia. These latter fibres leave the superior commissure and pass to the epiphysis in order to constitute its nerve supply. In most cases a distinct decussation of these innervating fibres is found to take place.

The posterior fibres of the commissura habenularum in the human brain are the homologue of the superior commissure of lower vertebrates; and Weigert-Pal preparations of this commissure show that some of its fibres enter the basal portion of the pineal body. These

latter nerve fibres form a complete decussation, and correspond to the fibres which in lower vertebrates pass to innervate the epiphysis. Further, it is found that the innervation of the pineal body in the human brain is bilateral—a fact which indicates that the origin of this structure is also probably *bilateral*, more especially as it has been already shown by other observers that the pineal eye in Lacertilia possesses a *unilateral* innervation. There can now be no doubt regarding the fact that the vertebrate epiphysis was a *paired* ancestral structure, possessing a bilateral nerve supply. It is further of great interest to note that evidence of the existence of these innervating fibres can still be found in the adult condition of *man*—the most highly evolved of all the vertebrata.

This paper will be published *in extenso* in the April number of the *Journal of Anatomy and Physiology*.

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OF THE

# PROCEEDINGS OF THE ANATOMICAL SOCIETY OF GREAT BRITAIN AND IRELAND, 1902–1903.

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